Plan Life Management: Set of *coordinated* and *systematically designed actions* to achieve a *safe* and *profitable* plant for *as long as possible* with an *acceptable* performance level.

- **Plan Life Management**
  - Increased of cost and lost of safety margin concept due to aging

- **Evaluation, Early Detection and Resolution of the effects of Degradation Mechanisms Related to Aging** (maintenance or replacement)

- **Prioritize and select systems and components**
- **Plan Design**
- **Plan implementation and continuos improvement**

**Systematic process management**
Maximize effectiveness by coordination of programs and activities

Minimize degradation of component systems and structures

Plan coordination
Regulatory requirement
Documentation management

Aging knowledge
Materials and properties
Aging mechanism
Failure modes

Monitoring and evaluation
In service inspection
Surveillance

Early detection of degradation, detection methods

Operation based on procedures
Environmental impact control

PDCA process (IAEA SR 15)

PLAN

DO

ACT

CHECK
Obsolescence

- Long Expected plants life
- Many old existing NPP and RR. Plan life extension
- High speed of technological changes

- Analogic technologies without technical support and no spare parts availability
- Suppliers that no longer exist
- Equipment without the required functionalities
- Unresolved aging threatens the security and income
- Higher maintenance and operation cost
- The staff is retiring and the new professionals are not aware of old technologies
- Could have regulatory constraints that require the up grade
Modernization (digital technologies)

Aspects to evaluate

- Obsolescence state of each I&C sub-system
- Failure rate impact and availability
- Maintenance and operation cost
- Regulatory requirement
Process challenges in modernization

- System or sub system to up-grade
- Best technology to implement (FPGA, ASIC, PLC, SW)
- Best way to implement the up-grade (incremental or in one outage)
- Provider to contract (long term technologies support)
- Workforce needed (full or part time?)
- Interfaces between old and new technologies
- Profit vs cost evaluation
- Degree of automation (auto test, auto storage, auto control)
<table>
<thead>
<tr>
<th>Process Challenge in modernization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Necessarily Involve three coordinated parties (Utility, Vendor, Regulator)</td>
</tr>
<tr>
<td><strong>Functionality</strong>: Incorporate new features not available with old system</td>
</tr>
<tr>
<td><strong>Obsolescence</strong>: Shorter Average life of new technologies. Modernization strategy</td>
</tr>
<tr>
<td><strong>Versatility</strong>: Expansion capacity and easy of upgrading</td>
</tr>
<tr>
<td><strong>Human factors</strong>: Operators Interfases, Automation by computer systems</td>
</tr>
<tr>
<td><strong>Security</strong>: Current specifications with Redundancy, Diversity and Independence</td>
</tr>
<tr>
<td><strong>Económics</strong>: Costs, Cash flow, ROI, Budgets</td>
</tr>
</tbody>
</table>
To take in mind

- **Greater V&V expenses** (Design process and functional requirements)
- **Common cause failures** in digital systems. New failures modes
- **Intensive testing required** (Factory Acceptance and Site Acceptance Test)
- **Re-Commisioning (re-licensing)** the new system
- **Capacitation**
- **Licensing**
Benefits

✓ Easily available technology
✓ Increases confidentiality, functionality and flexibility
✓ More precise control
✓ Increases Security (self diagnostic)
✓ Less human errors (automation)
✓ Simplify faults detection by autodiagnostic
✓ Better HMI simplify operation
✓ More professionally attractive to new generation professionals
✓ Generally uses fewer cable. Fewer maintenance.
Modernization Plans

Incremental:
In parts, during programable stops

- Don`t need all resources at the same time
- Lessons learned improve nexts stages
- It´s possible to incorporate last new technologies in each stage
- Easier to control

- Needs great coordination to implement in a stop
- Need to define clearly what is going to upgrade
- Needs interfaces between the new and the old technologies in each stage
- More failure possibilities due to diferents technologies and operating ways
- Continous personal training
- Diversity of instruments
- Complex management
- Poor standarization
Modernization Plans

Monolithic In one action

✓ Don’t need the same level of coordination
✓ Don’t need periodic interfaces
✓ Less human errors
✓ Great standardization
✓ One monolithic capacitation period

✓ Substantial initial finance outlay
✓ Longer stop to upgrade than a programmable one
✓ More complex licensing due to complex upgrade
Argentine Organizational Situation

Nuclear activities since 1994 divided in 3 areas

Investigation and development
Advice
R R’s Design and Construction
Radioisotops and Nuclear Medicine
Mining and fuels

Regulator Nuclear Authority
Regulate and Control Nuclear activity
Advice Federal Government

Atucha I and Embalse NPP Operator
Atucha II Management and Construction
Next Atucha II Operator
New NPP Constructor

Federal Government
### Argentine Reactors Overview

<table>
<thead>
<tr>
<th>Year</th>
<th>Reactor Name</th>
<th>Status</th>
<th>Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>1957.</td>
<td>RA-1 Research Reactor</td>
<td>In operation</td>
<td>Investigation</td>
</tr>
<tr>
<td>1967.</td>
<td>RA-3 Research Reactor</td>
<td>In operation</td>
<td>Radioisotops Producer</td>
</tr>
<tr>
<td>1969.</td>
<td>RA-4 Research Reactor</td>
<td>In operation</td>
<td>Academical Use</td>
</tr>
<tr>
<td>1987.</td>
<td>RA-6 Research Reactor</td>
<td>In operation</td>
<td>Medicinal</td>
</tr>
<tr>
<td>1997.</td>
<td>RA-8 Research Reactor</td>
<td>Stop operation in 1999</td>
<td>Investigation</td>
</tr>
<tr>
<td>1974.</td>
<td>Atucha 1 (CNA1)</td>
<td>In commercial operation</td>
<td>NPP</td>
</tr>
<tr>
<td>1980.</td>
<td>Atucha 2 (CNA2)</td>
<td>In construction since 04</td>
<td>NPP</td>
</tr>
<tr>
<td>1980.</td>
<td>Embalse (CNE)</td>
<td>In commercial operation</td>
<td>NPP</td>
</tr>
</tbody>
</table>

2011-2019: New projects under study CAREM, Atucha III
Argentine Energy production

24 GW

Without Atucha II

With Atucha II (2012)

Fossil: 47% (45%) Hidroelectric: 49% (48%)

Nuclear: 4%

7%
Technical Argentine NPP Overview

<table>
<thead>
<tr>
<th>Name:</th>
<th>Atucha I</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reactor Type:</td>
<td>PHWR</td>
</tr>
<tr>
<td>Contractor:</td>
<td>Siemens</td>
</tr>
<tr>
<td>Fuel:</td>
<td>Natural U *</td>
</tr>
<tr>
<td>Electric Power</td>
<td>357 MW</td>
</tr>
<tr>
<td>In operation:</td>
<td>Since 1974</td>
</tr>
</tbody>
</table>

Atucha I Nuclear Power Plant is located in Buenos Aires province, 100 Km from the city.

* Since July of 2001 CNA1 reactor uses slightly enriched Uranium (0.85% in weight)
I&C Modernization in Atucha I NPP

CNA I Reactor Protection System

New digital emergency reactor cooling system SHS (Teleperm XS). In op. 2003

New Emergency Power System (EPS). Controlled by Teleperm XS (D) in the safety functions and Simatic S7 in operational functions. Under construction

CNA I Reactor Control

New digital instrumentation (real time control rods information (Siemens and Hartmann & Brown). In op. 2005
CNA I  Reactor Neutron Flux Measurement

Digital “Neutronic Noise” data acquisition system and in vessel new neutron flux detectors  In op. 2007

CNA I  Reactor  Alarms and Signal Processing

VISUAL DATA Digital HMI real time data system  In op.1995

New alarms and a digital HMI from Teleperm XS SHS system
**Technical Argentine NPP Overview**

<table>
<thead>
<tr>
<th>Name</th>
<th>Embalse</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reactor Type</td>
<td>Candú 600</td>
</tr>
<tr>
<td>Contractor</td>
<td>AECL</td>
</tr>
<tr>
<td>Fuel</td>
<td>Natural U</td>
</tr>
<tr>
<td>Electric Power</td>
<td>648 MW</td>
</tr>
<tr>
<td>In operation</td>
<td>Since 1984</td>
</tr>
</tbody>
</table>

Embalse Nuclear Power Plant is located in Córdoba, 700 km away from Buenos Aires, next to Embalse Lake.
CNE  General Control NPP Computer

**New Digital Control Computer System (SC1890):** Three sub-system with a dual redundant configuration and high reliability.

- 30 years technical support contract.
- Simultaneous loss of two computers lead the plant to stop condition.

CNE  Electrohidraulic Turbine Control

**New Digital Shooting protection and by pass system:** rapid closure of steam valves admission and pressure control in sec Circuit)

**New Turbine instrumentation:** speed, temperature, vibration

**New stator Voltage regulator**
I&C Modernization in Embalse NPP

- CNE New Stop Monitoring System in main control room
- CNE New Digital Plant Variables Recorder system
- CNE New Siesmic monitoring system
- CNE New I&C water system
Atucha II Nuclear Power Plant is located in Buenos Aires province, very near Atucha I.
CNA II New Supervisory computer (OM690)

CNA II New digital monitoring and automation system in the Operational I&C

Siemens  SPPA T-2000
2 sub-systems

4 AS620 computers for automation and data acquisition (Process Automation System PAS)
2 permanent synchronized processors (slave as redundant) both connected with i/o plant data bus

OM690 computers for operator control and monitoring AS620 tasks

Fast measurement computer to monitor data, a operating terminal computer to screen data and a server to store and retrieve data.
2 redundant processing computers
I&C Modernization in Atucha II NPP

New digital monitoring and automation system in the Operational I&C
New Reactor controls system (Areva Teleperm XS System)

- Primary Pressure control
- Presurized level control
- Water Tank level control
- Outlet moderator temperature
- Reactor power control
- Control Rod position control
- Power density distribution
I&C Modernization in Atucha II NPP

CNAII Modernization Project Steps (challenge)

- Selection of Functional systems to changed.
- Concept reports for the I&C change
- Engineering guides for design
- Functional Diagrams.
- Measurements Diagrams.
- Design of Plant Screens
- Cabling and connection documentation and routing
- Application software elaboration
- Interfaces. Providers
- Elaboration of Factory Acceptance Test procedures
- Issue of work assemblies
- Control room design and installation
- Commissioning of the Central I&C digital System / Extended site FAT
Conclusions

- Strategic modernization long term plan
- Complex requirements, design, equipment, installation and licensing including documentation and training
- Difficult V/V activities to address digital I&C CCFs
- Risk management for delays and budget over run
- Collaborative team work (utility, vendor, regulator). Vendor support
- Way of implementing modernization (one stop or in steps)

But it´s neccessary to do it
Nuclear business must look beyond their own industry for the sake of allowing sustainable progression of modernization equipment.

Nuclear Industry have to impulse unique rules in qualification acceptance and in time to obsolescence to technologies suppliers.

**Environmental Equipment Qualification (IEEE 323, IEC, DNV, FM)**
- Less or non Common cause failures
- Verification of functional capabilities under significant operational and environmental stress including DBE (LOCA, Seismic event)
- Defense in depth no compromised (Redundancy and diversity)

**Time to obsolescence**
- Allow planification in modernization
- Spare parts available
- Cooperation user supplier

DNV: DET NORSKE VERITAS, FM Approvals
IEEE Institute of Electrical and Electronic Engineers
IEC: International Electrotechnical Commission
Muchas Gracias

Thank you